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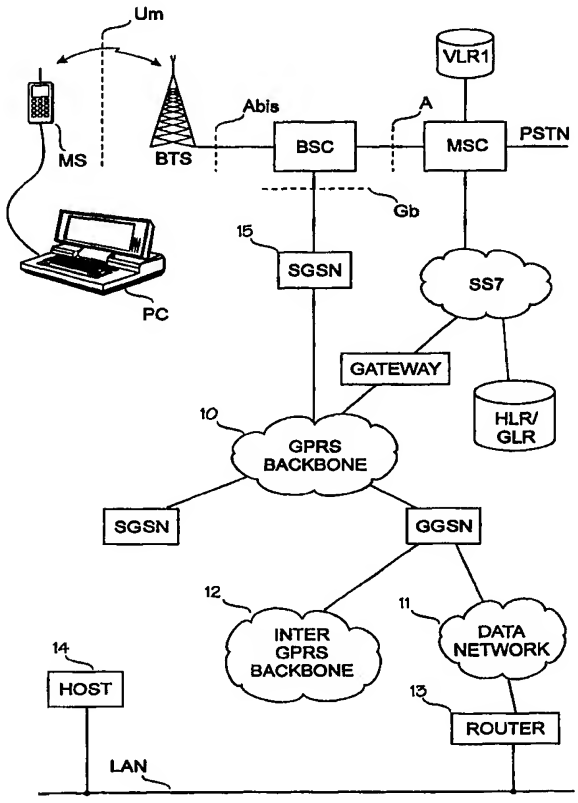
(54) Title: DETERMINATION OF SERVICE SITUATION IN PACKET RADIO NETWORK

(57) Abstract

A method for indicating the prevailing service situation in a packet radio network (1, 2) which includes at least one base station (BTS) and at least one terminal equipment (MS, PC), and where several classes for the quality of service have been determined. In accordance with the invention, at least one parameter representing the service situation of the packet radio network is determined and this parameter is made available to the terminal equipment (MS, PC). The parameter can be determined in some fixed network element of the network, such as a base station system (BSS) or a support node (SGSN). Alternatively, the parameter can be determined in the terminal equipment (MS, PC). The parameter can be sent simultaneously to several terminal equipments (MS, PC) on a broadcast channel, preferably on BCCH or PBCCH or as a multicast transmission (e.g. Point–To–Multipoint) or it can be sent to one terminal equipment at a time as a Point–To–Point transmission or a short message, for example. If the parameters are sent to all terminal equipments at the same time, it is most advantageously to send simultaneously the parameters representing the situation of all the classes for the quality of service.



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DETERMINATION OF SERVICE SITUATION IN PACKET RADIO NETWORK

BACKGROUND OF THE INVENTION

The invention relates to a method for transmitting the prevailing service situation of the telecommunication connection to the subscriber.

The invention will be explained primarily in connection with packet radio systems, such as GPRS, but it can also be applied to other kinds of telecommunication systems. Figure 1 shows the parts of the packet network essential for understanding the invention. Mobile stations MS communicate with base stations BTSn (Base Transceiver Station) over an air interface Um. Base stations are controlled by base station controllers BSC which are connected to mobile switching centres MSC. The subsystem managed by the base station controller BSC, including the base stations controlled by it, is generally referred to as a base station subsystem BSS. The interface between the centre MSC and the base station subsystem BSS is called an A-interface. The part of the mobile communication system on the side of the MSC at the A-interface is known as a network subsystem NSS. Correspondingly, the interface between the base station controller BSC and the base station BTS is called an Abis-interface. The mobile switching centre MSC attends to the switching of incoming and outgoing calls. It carries out similar tasks as the exchange of the public switched telephone network PSTN. In addition, it carries out functions characteristic of mobile telephone traffic only, such as subscriber location management, in co-operation with network subscriber registers which are not shown separately in Figure 1.

A conventional radio connection used in digital mobile communication systems is circuit-switched, which means that the radio resources reserved for a subscriber are kept reserved for this connection for the duration of the call. Packet radio service GPRS (General Packet Radio Service) is a new service designed for digital mobile communication systems, such as GSM systems. The packet radio system is described in ETSI recommendations TC-TR-GSM 02.60 and 03.60. By means of a packet radio service, a user of the mobile station MS can be provided with a radio connection which efficiently utilizes radio resources. In a packet-switched connection radio resources are reserved only when speech or data is to be sent. Speech or data is assembled into packets of a specific length. When such a packet has been sent over the air interface Um and the sending party does not immediately have the next

packet to send, the radio resource can be released to the use of other subscribers.

The system of Figure 1 includes a separate Serving GPRS Support Node, that is, an SGSN 15 which controls the operation of the packet data service on the network side. This control includes, for example, registrations of the mobile station to the system and from the system (Logon and Logoff, respectively), updating mobile stations location and routing data packets to the correct destination. In the context of the present application, "data" broadly interpreted refers to any information transmitted in a digital mobile communication system, including, but not limited to speech encoded into a digital form, data transmission between computers or telefax data. The SGSN may be located in connection with the base station BTS, the base station controller BSC or the mobile switching centre MSC or it may be located separately from them. The interface between the SGSN and the base station controller BSC is known as a Gb-interface.

In a packet radio network a situation is conceivable in which the subscriber using a computer PC is in contact with another computer 14 via a packet network 10, a data network 11, a router 13 and a local area network LAN. There is an ongoing long data transmission or several successive short data transmissions between the computers PC and 14 in accordance with Internet FTP protocol, for example. At the same time, a user of the computer PC or some other user starts an interactive session in accordance with Internet Telnet protocol, for example. If a packet of each interactive session had to wait at nodes along the connection until the long data transmission had been terminated, the response times of the interactive session would grow so long that the use of the service would no longer be sensible.

Network operators typically determine several classes for the quality of service (QoS) so that in a higher class for the quality of service the propagation delay (and possibly also the probability of losing the packet) is smaller than in a lower class for the quality of service. In this invention, propagation delay is the most significant parameter connected with the quality of service. The operator may determine three classes for the quality of service, for example, for which two propagation delays T_{AVE} and T_{95} have been determined, the first (T_{AVE}) of which determines the average propagation delay of the packet in the network of the operator and the second (T_{95}) determines such a delay that 95 per cent of the packets are transmitted on a smaller delay

than T_{95}. The correspondence of classes for the quality of service and propagation delays could be as follows:

Table 1, a typical correspondence of classes for the quality of service and propagation delays:

Quality of service	T_{AVE} (ms)	T_{95} (ms)
1	400	1000
2	800	2000
3	1600	4000

(It is obvious that these values are only examples. There may be more than three classes for the quality of service, a median can be employed instead of the arithmetic average and other percentages can be used instead of 95 per cent.)

There are several problems in the arrangement described above. For example, there are no pre-determined protocols for transmitting the prevailing service situation to the user and/or the application programs and no specified procedures with which the application programs could automatically adapt to changes in the service situation. Although the users or the application programs may estimate and determine independently the prevailing service situation in the quality of service which has been negotiated at each time, the users or the application programs cannot receive information independently about other classes for the quality of service and thus cannot make any objective conclusions on whether the quality of service should be re-negotiated to be higher or lower.

BRIEF DESCRIPTION OF THE INVENTION

The object of the invention is to develop a method for solving the problems mentioned above. The objects of the invention are achieved by a method that is characterized by what is stated in the characterizing part of claim 1. The dependent claims relate to the preferred embodiments of the invention.

The invention is at its simplest implemented by establishing a method for indicating the service situation in a packet radio network which includes at least one base station BTS and at least one terminal equipment (a mobile station MS and a computer PC possibly connected or integrated thereto), and where several classes for the quality of service have been

determined. According to the invention, at least one parameter describing the service situation of the packet radio network is determined and this parameter is made available to the terminal equipment (MS, PC). In this case the terminal equipment (the person using it and/or the application program to be executed therein) has available exact and objective information on the service situation of the network. The user and/or application program may conclude, for example, that information is received slowly regardless of the good service situation in the network. In this case the application program or its user can conclude that the delay is caused by the loading of the server in which case the negotiation of the quality of service into a better one will not improve the situation. This conclusion cannot be made objectively if the service situation is determined subjectively in the terminal equipment (by estimating or measuring the effective data transmission rate) as the terminal equipment or its user cannot distinguish the delays caused by the network from the delays caused by the server.

According to a preferred embodiment of the invention, the network determines the prevailing service situation in each class for the quality of service and this information is transmitted to the terminal equipment. In this case the terminal equipment (or its user) has available objective information on the service situation prevailing in the other classes for the quality of service. The application to be executed in the terminal equipment or its user may then decide to negotiate a higher or a lower class for the quality of service, as required.

According to another preferred embodiment of the invention, the service situation in the neighbouring base stations is used as a criterion in connection with handover, in which case the mobile stations can be handed over to a base station whose audibility is poorer but the service situation better (loading smaller) than in the base station which serves the mobile station.

The advantage of the method and system of the invention is a more efficient use of packet radio network resources as the users and/or applications making decisions (change of the service quality or handover) have available objective information on the prevailing service situation.

BRIEF DESCRIPTION OF THE FIGURES

The invention will now be explained in more detail in connection with preferred embodiments, with reference to the appended drawing, wherein:

Figure 1 shows the parts of the packet network essential for understanding the invention.

DETAILED DESCRIPTION OF THE INVENTION

As was stated above, the invention is at its simplest implemented by establishing a method for indicating the service situation in a packet radio network which includes at least one base station BTS and at least one terminal equipment (a mobile station MS and a computer PC possibly connected or integrated thereto), and where several classes for the quality of service have been determined. According to the invention, at least one parameter representing the service situation of the packet radio network is determined and this parameter is made available to the terminal equipment (MS, PC).

According to one preferred embodiment, the parameter representing the service situation is determined in some fixed network element of the network, such as the base station system BSS or the support node SGSN. Alternatively, said parameter can be determined in the terminal equipment (MS, PC).

The prevailing service situation in the service quality used by the mobile station MS can be determined in several different ways. One possible technique is based on that the parameter is determined on the basis of the utilization ratio of the capacity of the base station system BSS, for example by determining the ratio of free channels to reserved channels. The parameter can also be determined by following on which probability and/or delay the mobile stations are able to reserve resources, such as traffic channels. It is also possible to calculate the number of packets sent to the mobile station MS per a time unit and maintain the moving time average of this number. Alternatively, it is also possible to use the fact that in most packet networks packets are time stamped when they arrive at the network, in which case the parameter representing the service situation may be determined on the basis of the time stamps of the downlink packets, for example. On the basis of this time stamp, it is possible to determine the two propagation delays T_{AVE} and T_{95} (or one of them) described in connection with Table 1. This calculation may be carried out in the support node SGSN, the base station controller BSC or the base station BTS, for example.

If the parameter representing the service situation is determined in some fixed network element, such as the base station system BSS or the

support node SGSN, this parameter can be sent to the terminal equipment (MS, PC) on a broadcast control channel. Suitable channels in the GPRS system are BCCH or PBCCH, for instance. Alternatively, this parameter can be sent to terminal equipment (MS, PC) as a multicast transmission, such as a Point-To-Multipoint transmission. Instead of the multicast transmission, the parameter can be sent to one terminal equipment (MS, PC) at a time, as a Point-To-Point transmission or as a short message in the GPRS system. A multicast transmission and an individual transmission may be combined so that the parameter is sent to the terminal equipment generally as a multicast transmission but to a terminal equipment that has just registered to the network individually as a Point-to-Point transmission or as a short message, for example.

In order that the user of the terminal equipment or the application program executed therein could make objective decisions concerning the change of the service quality, it is advantageous that said parameter is determined in more than one class for the quality of service. If the parameters are sent to all terminal equipments at the same time (e.g. broadcast or multicast), it is most advantageous to send simultaneously the parameters representing the situation of all the classes for the quality of service. If the parameters are instead sent individually to the terminal equipments, capacity may be saved by sending primarily only the parameters representing the situation of the upper and lower classes for the quality of service in addition to the quality of service used at each time.

Conventional cell and handover algorithms are usually based only on signal quality. There may also be situations where the neighbouring base station of the base station that serves the mobile station would have more capacity and it could provide a faster connection than the base station that serves the mobile station at that moment. Then it is advantageous if the parameter representing the service situation is determined at least for two base stations (the base station that serves the mobile station and the neighbouring base station with the best audibility), and the parameter is employed as a crossover criterion. One possibility to employ the capacity of the base station as a crossover criterion is to weigh signal strength measurements so that the base station which has a great deal of unused capacity is notified of signal strength higher than the actual value, and vice versa. In this way changes to known crossover algorithms are minimal.

When information on the service situation of the classes for the quality of service has been made available to the terminal equipment (either by calculating some parameter representing service in the terminal equipment or by calculating the information in the network and by sending it to the mobile station), this information has to be made available to application program and/or its user. The information on the service situation of the classes for the quality of service can be employed in the application program for example so that the criteria have been determined in advance, on the basis of which criteria the application negotiates the class for the quality of service higher or lower if the parameter representing the service situation is smaller or greater, respectively, than some predetermined threshold value. Then it is also advantageous to determine a specific hysteresis, for example, in such a manner that a higher (faster) class for the quality of service is negotiated if the parameter falls below the threshold value by 10 per cents and a lower (less expensive) class for the quality of service is negotiated if the parameter exceeds the threshold value by 10 per cents. Instead of the hysteresis or in addition to it, time delay can be determined for example so that the quality of service is re-negotiated only if the parameter has been below or above the threshold value for a certain time, such as one minute. In that case, however, the new class for the quality of service can be negotiated immediately if there is a great deviance from the threshold value towards a poorer value (e.g. if the average propagation delay exceeds two times the normal value). In this way the terminal equipment and the application program executed therein can make decisions independently, without disturbing the user, by means of which decisions the ratio of the service level to costs is maintained at the optimal level.

In some cases it should be possible to change the quality of service in a manner that is almost impossible to program in advance. For example, a situation is conceivable in which the user uses the mobile station (and a computer connected or integrated thereto) for taking care of bank transactions when waiting for the departure of the aeroplane. When the departure of the aeroplane is announced, the user is probably willing to pay considerably for the improvement of the service quality to finish the bank transaction. A reverse example may be a user who wishes to start a data transmission by using a high class for the quality of service (in order than the interactive phase would take place as fast as possible) but the actual data transmission can take place

slower in a less expensive class for the quality of service. In order that the user of the terminal equipment could individually decide to change the quality of service, the user has to be informed of the parameter representing the service situation. The service situation can be transmitted to the user for example so that there is in a corner of the screen of the mobile station MS and/or the computer PC an element (e.g. a number, a dot or a bar) indicating the prevailing service situation, some feature (such as a numerical value, the size, the colour or the blinking speed) of the element being dependent on the service situation. By pointing to this element with the transfer mechanism of the cursor (such as keyboard, mouse, etc.), the user can start a dialogue where more exact information is shown and through which the user can re-negotiate the quality of service. When the quality of service is changed automatically by a negotiation between the application program and the network, it may be advantageous to produce some audio signal so that the user would have a chance to accept or discard the change of service quality suggested by the application program.

It will be evident to those skilled in the art that the basic idea of the invention may be realized in various ways. The invention and its embodiments are therefore not restricted to the examples described above but they may vary within the scope of the claims.

CLAIMS

1. A method for indicating the prevailing service situation in a packet radio network which includes at least one base station (BTS) and at least one terminal equipment (MS, PC), and where several classes for the quality of service have been determined;

characterized by

- determining at least one parameter representing the service situation of the packet radio network; and

- supplying this parameter to the use of the terminal equipment (MS, PC).

2. A method according to claim 1, **characterized** in that the parameter is determined in some fixed network element of the network, such as a base station system (BSS) or a support node (SGSN).

3. A method according to claim 1, **characterized** in that the parameter is determined in the terminal equipment (MS, PC).

4. A method according to claim 2 or 3, **characterized** in that the parameter is determined on the basis of the utilization ratio of the capacity of the base station system (BSS).

5. A method according to claim 2 or 3, **characterized** in that the parameter is determined on the basis of time stamps of the downlink packets.

6. A method according to claim 2 or 3, **characterized** in that the parameter is determined by the success probability of resource reservation attempts or on the basis of the waiting times of resource reservations.

7. A method according to claim 2, **characterized** in that the parameter is sent to the terminal equipment (MS, PC) on a broadcast channel, preferably on BCCH or PBCCH.

8. A method according to claim 2, **characterized** in that the parameter is sent to the terminal equipment (MS, PC) as a Point-To-Multipoint transmission.

9. A method according to claim 2 or 8, **characterized** in that the parameter is sent at least to some terminal equipments (MS, PC), preferably to a terminal equipment that has just registered to the network, individually, such as a Point-To-Point transmission or a short message.

10. A method according to claim 2, **characterized** in that the parameter is determined in more than one class for the quality of service.

11. A method according to claim 2, **characterized** in that the parameter is determined in all classes for the quality of service in the packet radio network.

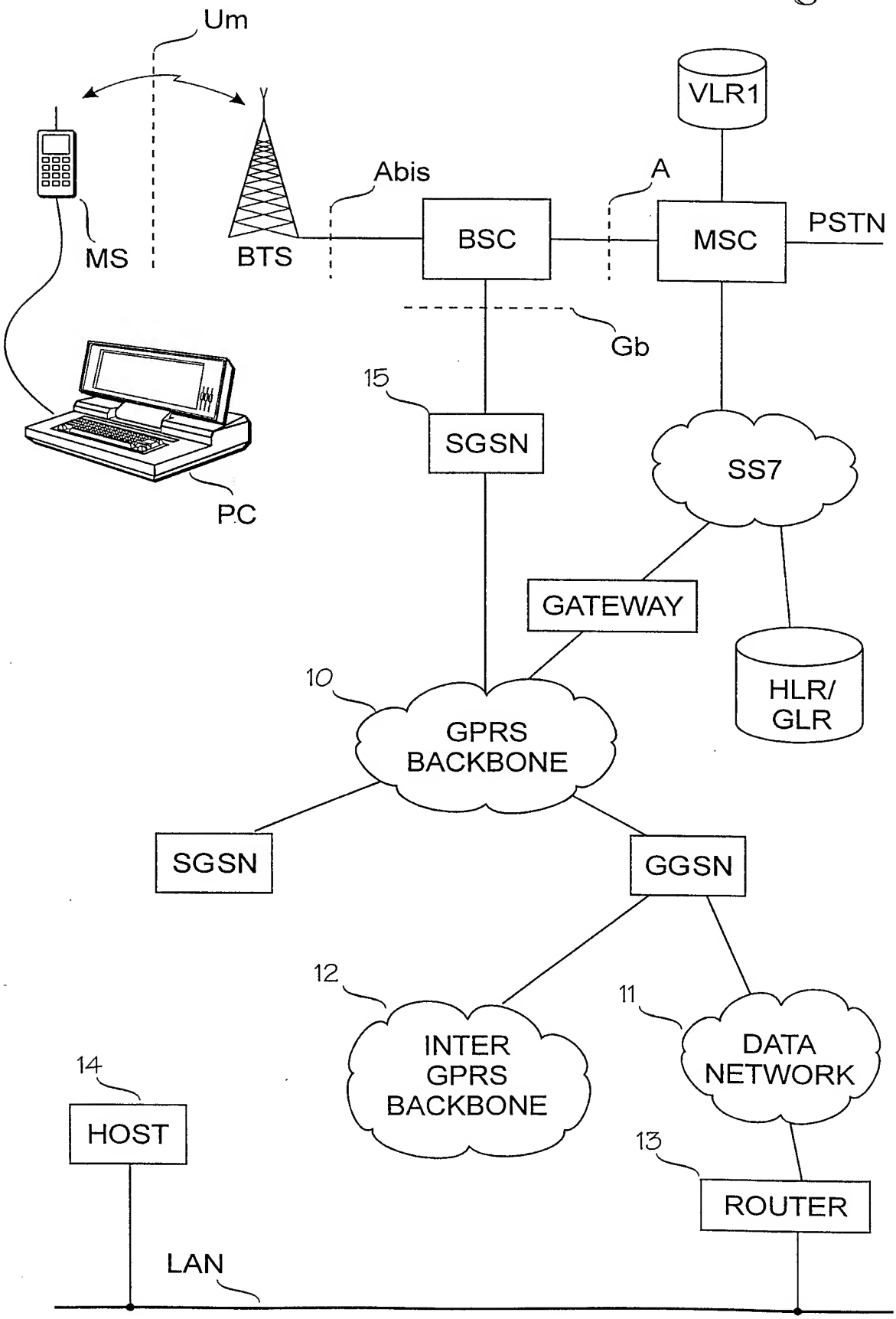
12. A method according to claim 1, **characterized** in that the parameter is determined relating to at least two base station systems (BSS) and the parameter is employed as a crossover criterion.

13. A method according to any one of claims 1 to 12, **characterized** in that the parameter is transmitted to the user of the terminal equipment (MS, PC).

14. A method according to any one of claims 1 to 12, **characterized** in that the parameter is made available to the application program being executed in the terminal equipment (MS, PC).

15. A method according to claim 14, **characterized** in that at least one nominal value is defined for said application program and the application program independently negotiates a new class for the quality of service if said parameter deviates essentially from said nominal value.

Fig. 1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LAN

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 98/00034

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04L 12/56
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q, H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

30/06/98

International application No.
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